

The Effect of Surface Chemical Functionality upon Ice Adhesion

In nature, anti-freeze proteins present in fish utilize specific organic functionalities to disrupt ice crystal formation and propagation. Based on these structures, surfaces with controlled chemical functionality and chain length were evaluated both experimentally and computationally to assess the effect of both parameters in mitigating ice formation. Linear aliphatic dimethylethoxysilanes terminated with methyl or hydroxyl groups were prepared, characterized, and used to coat aluminum. The effect upon icing using a microdroplet freezing apparatus and the Adverse Environment Rotor Test Stand found hydroxyl-terminated materials exhibited a greater propensity for ice formation and adhesion. Molecular dynamics simulations of a silica substrate bearing functionalized species of similar composition were brought into contact with a pre-equilibrated ice crystal. Several parameters including chain mobility were monitored to ascertain the size of a quasi-liquid layer. The studies suggested that chain mobility affected the interface between ice and the surface more than terminal group chemical composition.

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